United States Patent [19]

Freiheit

[11] **3,830,255**

[45] **Aug. 20, 1974**

[54] **VALVE ASSEMBLY**

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[73] Assignee: **FMC Corporation,** San Jose, Calif.

[22] Filed: **Nov. 24, 1972**

[21] Appl. No.: **309,553**

[52] **U.S. Cl.** **137/543.19**

[51] **Int. Cl.** **F16k 15/02**

[58] **Field of Search**..... 137/533.11, 533.13, 533.19, 137/533.21, 535, 539, 540, 543, 543.13, 543.15, 543.17, 543.19, 543.21, 543.23; 251/362; 29/157.1, 453; 24/243 K; 85/8.8

[56] **References Cited**

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R18,144	8/1931	Heiermann	85/8.8 X

Primary Examiner—Robert G. Nilson

Attorney, Agent, or Firm—A. J. Moore; C. E. Tripp

[57] **ABSTRACT**

A valve assembly having a machined valve seat with a stamped cage press fitted on the seat. In one embodiment a disc valve is urged against the valve seat by a variable rate conical spring having its large end engaging the valve disc and its small end encircling a flange on a spring retainer held in place by a snap ring engaging surfaces of the cage windows. The spring when compressed nests about the retaining flanges in less space than two wire diameters of the spring providing a short valve with high lift and high flow rate. In a second embodiment, flanges pressed inwardly to form the valve cage windows are used to guide a ball type valve.

3 Claims, 6 Drawing Figures

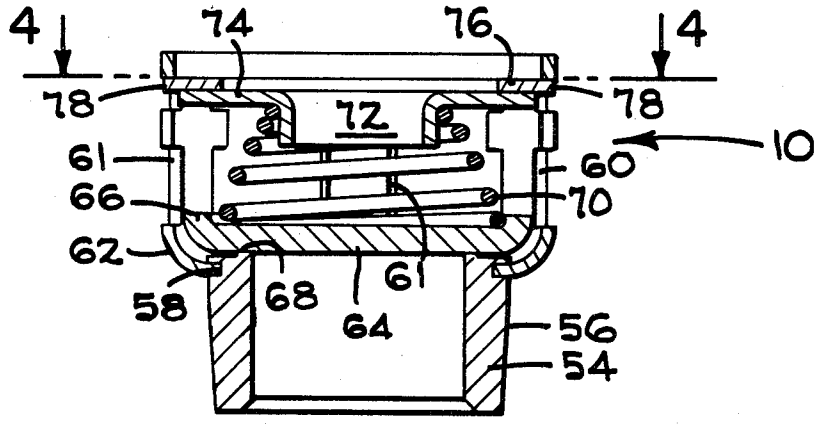
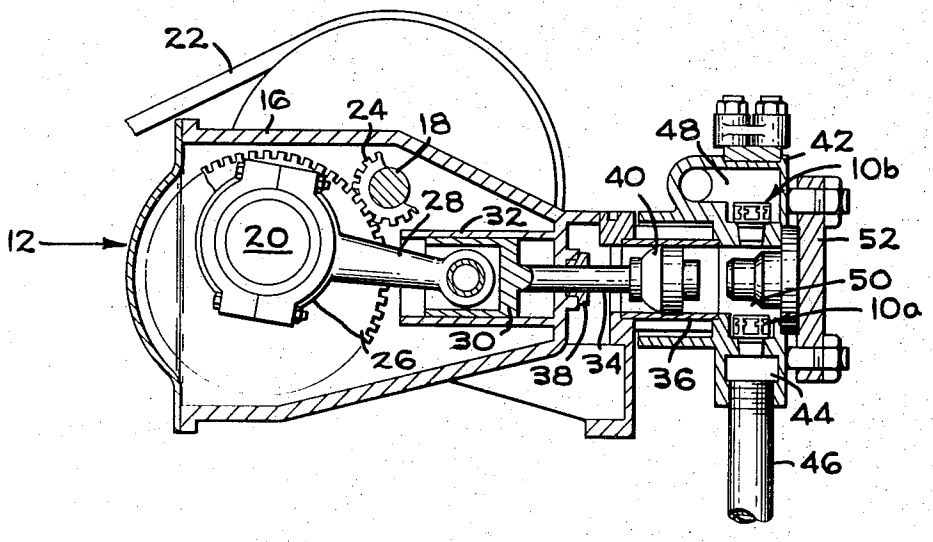


FIG_1



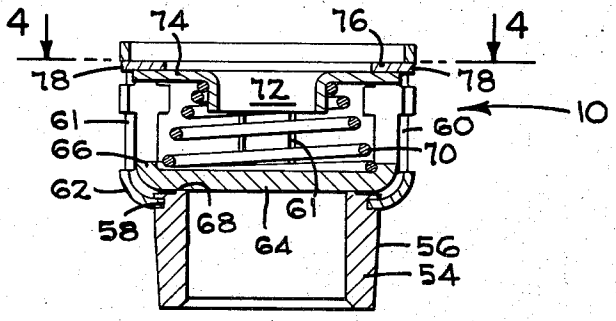


FIG_2

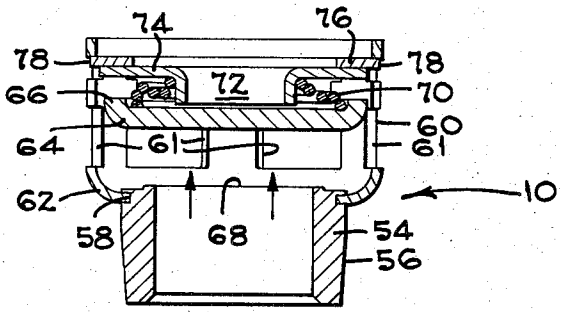


FIG_3

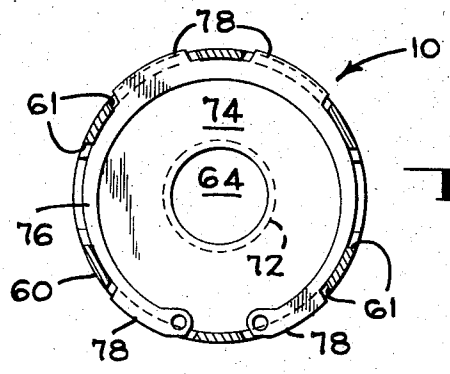


FIG_4

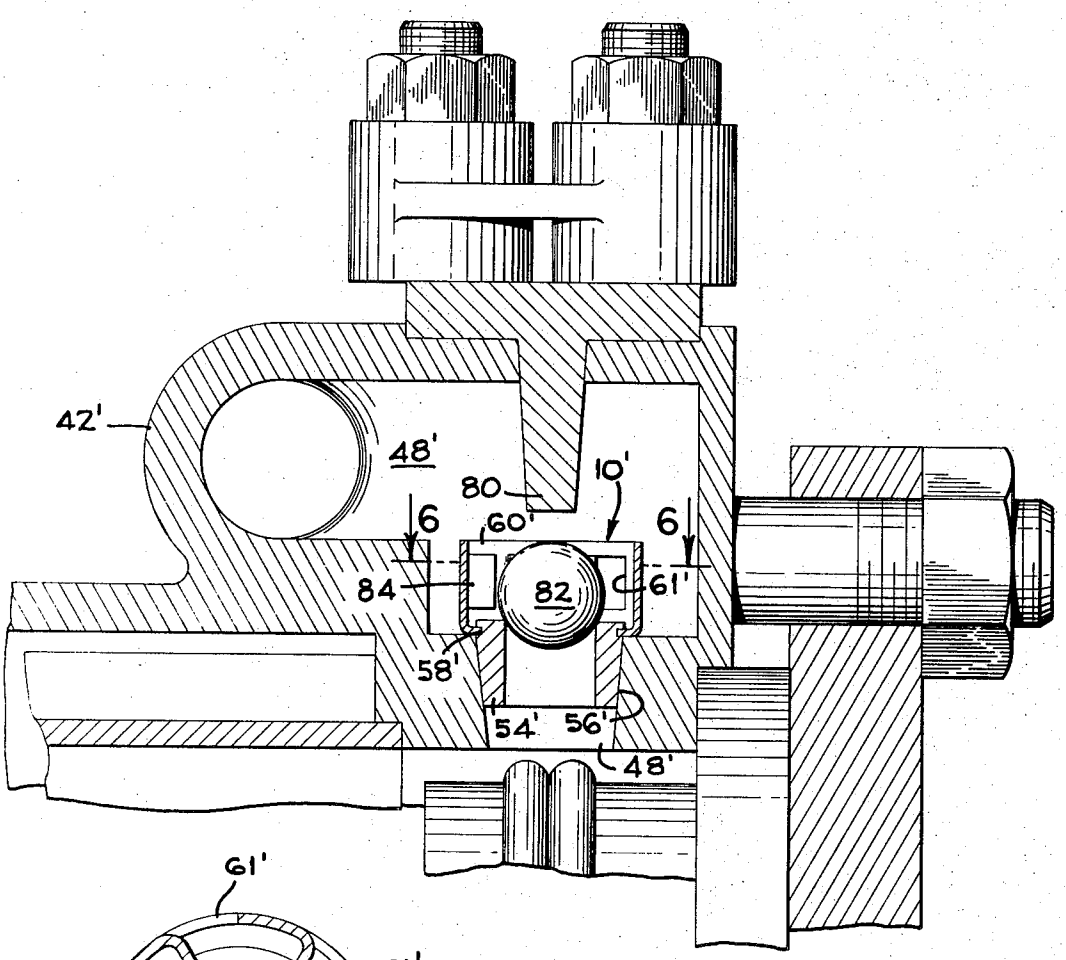


FIG_5

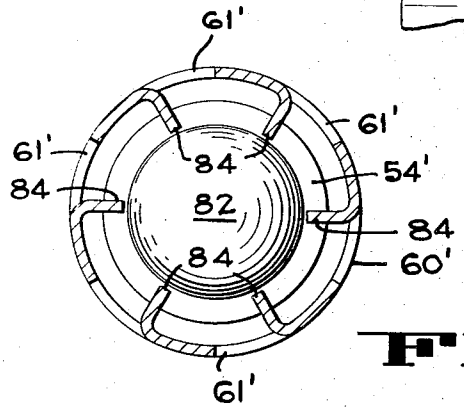


FIG_6

VALVE ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to valve assemblies and more particularly relates to valves for high pressure pumps or the like.

2. Description of the Prior Art

High pressure pumps of the type disclosed in U.S. Pat. No. 2,038,747 to Magnuson or U.S. Pat. No. 3,030,978 to Griffith et al. frequently pump corrosive or abrasive materials and accordingly the inlet and discharge valve assemblies used in such pumps are made, to a large extent, from corrosive resisting material such as stainless steel which is very difficult to machine.

Normally the valve cage and valve seat of such valve assemblies are either machined from a single piece of solid stock, as in the Magnuson pump, requiring that the high machine cost be absorbed by the manufacture; or the valve cage and valve seat are not permanently attached to each other as in the Griffith et al. pump. In the Griffith et al. pump the several separate valve parts must be laboriously assembled and disassembled each time a valve assembly is put into or removed from the pump.

Also, many of the prior art valve assemblies, such as the Griffith et al. valve assemblies, use cylindrically wound helical springs to return the valves to their valve seats. This type of spring has a near constant spring rate and has a long solid height which makes it necessary to provide a longer valve assembly than desirable in order to provide the desired high flow rates.

SUMMARY OF THE INVENTION

The valve assembly of the present invention includes a stainless steel valve seat which requires a minimum of machining, and a stainless steel cage which has windows stamped therein and has one end bent inwardly and press fitted into a groove machined in the outer periphery of the valve seat.

In order to provide a short valve with high lift and high flow rates, a conical spring is disposed between a disc valve having an upturned peripheral flange for retaining the large end of the spring, and a valve retainer having a small diameter centrally disposed opening defined by an annular flange for retaining the small end of the spring. The valve retainer is held within the cage by a snap ring having outwardly projecting lobes which project into the windows formed in the cage.

Since the spring is a conical spring, it has a variable spring rate which minimizes vibrational problems and provides high initial valve closing forces with low final closing forces for quick, low pressure opening of the suction valve. Also, the compressed height of the spring is quite short.

The second embodiment of the valve assembly of the present invention is of the ball type and includes a valve cage bent inwardly and press fitted to a valve seat. The ball is guided by radial flanges which are pressed inwardly from the valve windows during the cage stamping operation.

It is therefore one object of the present invention to provide a valve assembly having a stamped cage bent inwardly and press fitted into a machined valve seat.

Another object is to provide a valve having a conical spring for urging a disc valve toward the valve seat with varying forces.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a vertical central section through a conventional high pressure pump with a pair of valve assemblies of the present invention mounted therein.

FIG. **2** is an enlarged vertical central section of one of the valve assemblies with the valve closed.

FIG. **3** is an enlarged section similar to FIG. **2** but with the valve open.

FIG. **4** is a section taken along lines **4—4** of FIG. **2** illustrating the snap ring connection to the cage.

FIG. **5** is an enlarged vertical section through a portion of a pump similar to the pump of FIG. **1** with a modified form of valve assembly therein.

FIG. **6** is a section taken along lines **6—6** of FIG. **5.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

Two of the valve assemblies **10** (FIGS. **2** and **3**) of the present invention are illustrated as being used in a high pressure pump **12** to act as an inlet valve **10*a*** (FIG. **1**) and a discharge valve **10*b***.

The pump **12** includes a housing **16** having a drive shaft **18** and a crank shaft **20** journaled thereon. The drive shaft **18** is driven by a belt drive **22,** or the like, from a power source (not shown). A pinion **24** keyed on the drive shaft **18** meshes with a large diameter gear **26** keyed on the crank shaft **20** thereby driving the crank shaft and a crank arm **28** journaled to the crank shaft. The connecting rod pivotally connected to a crosshead **30** mounted for reciprocation in a sleeve **32** within the housing. One end of a connecting rod **34** is secured to the crosshead **30** and extends into a pump cylinder **36** through a packing gland **38** and has a pump piston **40** connected to its other end. The pump cylinder **36** is fitted within a pump body **42** having an inlet or suction passage **44** connected to a source of fluid by a conduit **46,** and a discharge passage **48.** Both passages **44** and **48** and the pump cylinder **36** communicate with a pumping chamber **50** which has an access opening opposite the pump cylinder. The access opening is normally closed in fluid tight engagement by an end cap **52.** The inlet valve **10*a*** is mounted in the inlet passage **44** and opens to allow a charge of fluid to enter the pumping chamber **50** when the pump piston **40** is moving away from the end cap **52.** The discharge valve **10*b*** is mounted in the discharge passage **48** and opens when the pump piston **40** is moved toward the end cap **52** to discharge a portion of the fluid from the pumping chamber **50.**

Although the valve assemblies have been disclosed and described as being used in a high pressure pump, it will be understood that such valve assemblies may be used in other apparatus for other fluid controlling purposes.

Each valve assembly **10** (FIGS. **2** and **3**) comprises an annular valve seat **54** having a frusto-conical surface **56** and an annular cage retaining groove **58** machined in its outer surface. A valve cage **60** is fabricated from stainless steel tube stock of cylindrical cross-section and has a plurality of fluid flow passages or windows **61** stamped therein. The valve cage **60** is rigidly connected to the valve seat **54** by pressing one end of the cage inwardly to define a generally concave annular flange **62** having its inner edge seated in the retaining groove **58.**

A valve disc **64** is fabricated from stainless steel plate stock by first stamping a disc from the stock and thereafter pressing a spring retaining flange **66** upwardly from the periphery of the disc. The finished valve disc **64** is then slidably fitted within the cage with its flat sealing surface resting in sealing engagement with the sealing surface **68** of the valve seat **54.** A conical spring **70** is then seated upon the valve disc **64** with its large diameter end guided by the flange **66.** The small diameter end of the spring is received around and guided by a flange **72** pressed downwardly (FIG. **2**) from a spring retainer **74** that is stamped from stainless steel plate stock and has an outside diameter slightly smaller than the inside diameter of the cage **60.**

As best illustrated in FIGS. **2** and **4,** the valve disc **64,** spring **70,** and spring retainer **74** are held in place within the cage **60** by an internal snap ring **76** which includes a plurality of outwardly projecting lobes **78** that are seated within and are urged against the upper edge of certain of the windows **61** when the valve is assembled and is oriented as indicated in FIGS. **2** and **3.**

It will be apparent that when two of the valve assemblies **10** are seated in the inlet passage **44** and the discharge passage **48** with their conical surfaces **56** wedged into similar surfaces in the passages **44** and **46** as indicated in FIG. **1,** that movement of the piston **40** to the left will cause low pressure fluid to open the inlet valve **10***a* as indicated in FIG. **3,** and close the discharge valve **10***b* as indicated in FIG. **2** thus drawing a charge of fluid into the pumping chamber **50.** When the piston **40** is moving to the right, the inlet valve **10***a* will be closed by high pressure and the discharge valve **10***b* will be open to discharge some of the fluid from the pumping chamber **50** for distribution out of the pump through the discharge passage **48.**

An important feature of the invention is that the conical spring **70** has its large end disposed against the disc valve **64** making it possible to fully open the valve in a very short distance since the conical spring is capable of telescoping within itself to a very short solid height which is less than twice the wire diameter of the spring. Also, by placing the wide or large diameter end of the spring **70** against the valve seat **64** and within the flange **66,** while the small diameter end is guided by the flange **62** of the spring retainer **74,** the spring provides very good control over the movement of the valve disc during the pumping operation.

Another important feature of the invention is that the spring's conical section creates a variable rate spring which minimizes vibrational problems in the valve, which problems are inherent in constant rate cylindrical springs. The variable rate conical spring also gives higher return forces when the valve is fully opened as compared to a much lighter force when the valve is near the closed position thus providing for quick low pressure opening of the suction or inlet valve **10***a* (FIG. **1**).

The second embodiment of the valve assembly **10'** of the present invention is illustrated in FIGS. **5** and **6** and is of the ball type. The valve **10'** is shown mounted in the discharge passage **48'** of a pump body **42'**, which body is quite similar to the pump body disclosed in FIG. **1** except that an abutment **80** is provided for maintaining a ball valve **82** within the valve assembly.

The valve assembly **10'** comprises an annular valve seat **54'** having a frusto-conical surface **56'** and an annular cage retaining groove **58'** machined in its outer surface. A valve cage **60'** fabricated from stainless steel tube stock has windows **61'** stamped therein with the material removed from the windows **61'** being pressed substantially radially inward, as indicated in FIG. **6,** to define ball guiding flanges **84.**

In the second embodiment of the invention, high fluid pressure below the ball valve **82** will lift the ball from its seat, while gravity plus low pressure below the ball will return it to its seat.

From the foregoing description it is apparent that both embodiments of the valve assembly, which is primarily constructed of difficult to machine stainless steel, include a fabricated valve cage bent inwardly and press fitted to an annular valve seat thereby minimizing the amount of machining required. The valve assembly of one embodiment also employs a conical spring having a variable spring rate and positioned so that its large end engages a disc valve to provide a valve assembly of short overall height and with a minimum tendency to chatter during the operation.

Although the best mode contemplated for carrying out the present invention has been herein shown and described, it will be apparent that modification and variation may be made without departing from what is regarded to be the subject matter of the invention.

What I claim is:

1. A valve assembly comprising an annular valve seat of hard metal having a groove in its outer periphery and having a sealing edge, a tubular valve cage of hard metal having a plurality of windows stamped therein to provide fluid flow passages, said cage having a flange extending inwardly from the outer periphery of said cage with the inner edges of said flange fitted tightly into locking engagement with said valve seat, a disc valve received in said cage for movement between a closed position in engagement with said sealing edge and an open position spaced from said edge, a conical spring having a large end engaging said disc valve, and spring retaining means for retaining the other end of said spring in said cage, said spring having coils adapted to overlap and telescope within adjacent larger coils for providing a solid height which is less than twice the wire diameter of the spring when said valve is moved to its fully open position for providing a valve assembly of short overall height, said spring having a variable spring rate with low final closing forces for quick low pressure opening of the valve when acting as a suction valve.

2. A valve assembly comprising an annular valve seat of hard metal having a groove in its outer periphery and having a sealing edge, a tubular valve cage of hard metal having a plurality of windows stamped therein to provide fluid flow passages, said cage having a flange extending inwardly from the outer periphery of said cage with the inner edges of said flange fitted tightly into locking engagement with said valve seat, a disc valve received in said cage for movement between a closed position in engagement with said sealing edge and an open position spaced from said edge, a conical spring having its large end engaging said disc valve, and spring retaining means for retaining the other end of said spring in said cage, said spring having coils adapted to overlap to provide a solid height which is less than twice the wire diameter of the spring when said valve is moved to its fully open position for providing a valve assembly of short overall height, said spring retaining means including an internal snap ring having lobes

thereon which project through certain of said windows and bear against the surfaces thereof opposed from said valve disc.

3. A valve assembly according to claim 2 wherein said retaining means additionally includes a retaining disc disposed between said valve disc and said snap ring, said retaining disc having a flange projecting into the small end of said conical spring to center the spring within said cage.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,830,255

DATED : August 20, 1974

INVENTOR(S) : FREDERICK E. FREIHEIT

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Abstract, line 8, change "flanges" to --flange--.

Column 2, line 30, change "crank arm" to --connecting rod--.

Signed and Sealed this

twenty-sixth Day of *August 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks